Parent Artery Occlusion for Intracranial Aneurysms

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Summary

Peripheral cerebral aneurysms are difficult to treat with preservation of the parent arteries. We report the clinical and angiographic outcome of 12 patients with cerebral aneurysms located peripherally.

In the past five years, 12 patients, six females and six males, presented at our institution with intracranial aneurysms distal to the circle of Willis and were treated endovascularly. The age of our patients ranged from four to 58 years with a mean age of 37 years. Seven of the 12 patients had subarachnoid and/or intracerebral hemorrhage upon presentation. Two patients with P2 dissecting aneurysms presented with mild hemiparesis and hypoesthesia, one patient with a large dissecting aneurysm complained of headaches and two patients with M3 dissecting aneurysms had mild hemiparesis and hypoesthesia of the right arm. Locations of the aneurysms were as follows: posterior cerebral artery in seven patients, anterior inferior cerebellar artery in two, posterior inferior cerebellar artery in one, middle cerebral artery in two.

Twelve patients with peripheral cerebral aneurysms underwent parent artery occlusion (PAO). PAO was performed with detachable coils. No patient developed neurologic deficits.

Distally located cerebral aneurysms can be treated with parent artery occlusion when selective embolization of the aneurysmal sac with detachable platinum coils or surgical clipping cannot be achieved.

Introduction

When aneurysms are treated endovascularly, the diameter of the parent vessel may be too narrow to allow passage of a microcatheter to the aneurysm and the configuration of the aneurysm may not be amenable to coil placement so that occlusion of the parent vessel may be the preferable treatment [2-10,12,13,17-19]. Several series of patients with peripheral intracranial aneurysms treated with parent vessel occlusion have been reported [4,5,9,10,17,18].

We report our results in twelve patients who underwent endovascular coil occlusion of peripheral vessels for the treatment of aneurysms.

Methods

From January 2002 to January 2007, 12 selected patients presented at our institution with peripheral intracranial aneurysms that were treated with embolization of the parent vessel. The patients were four to 58 years old (average age 37 years) at the time of treatment. Six patients were male and six were female. Five patients had subarachnoid hemorrhage, four patients had intracerebral hemorrhage, and one patient had intracerebellar hemorrhage. The aneurysms were located on peripheral intracranial branches in all 12 patients. Aneurysms were located on the right (n=1) and left (n=1) posterior inferior cerebellar arteries (PICA), the right anterior inferior cerebellar artery (AICA) (n=1), the right posterior cerebral

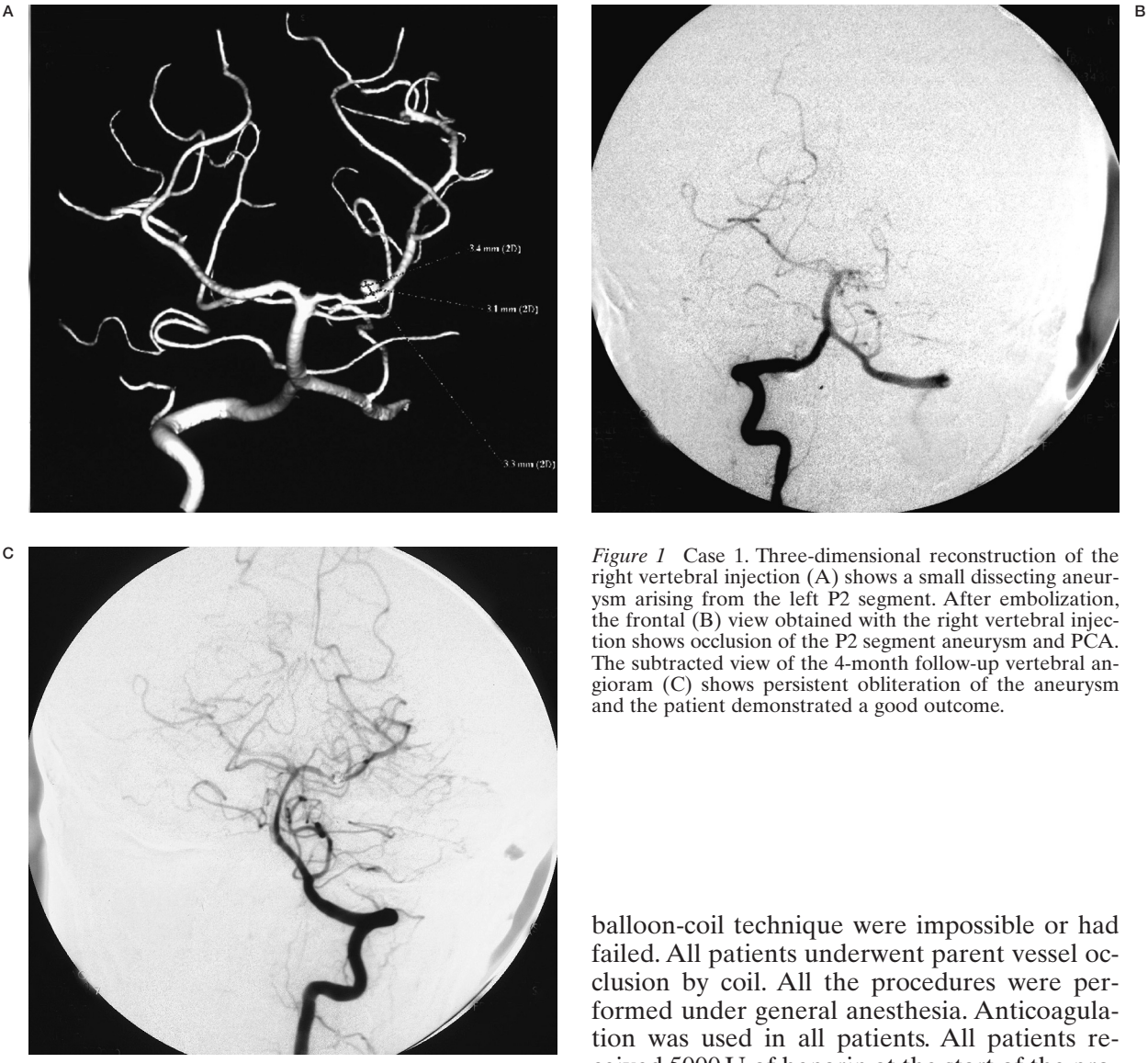


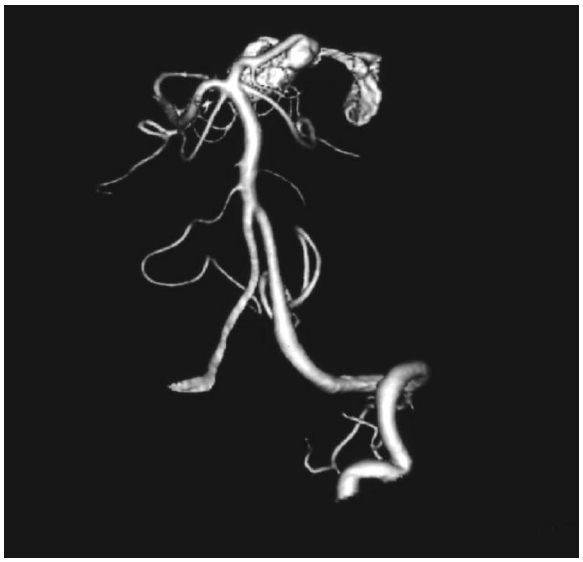
Figure 1 Case 1. Three-dimensional reconstruction of the right vertebral injection (A) shows a small dissecting aneurysm arising from the left P2 segment. After embolization, the frontal (B) view obtained with the right vertebral injection shows occlusion of the P2 segment aneurysm and PCA. The subtracted view of the 4-month follow-up vertebral angioram (C) shows persistent obliteration of the aneurysm and the patient demonstrated a good outcome.

artery (PCA) (n=3), the left PCA (n=5), and the parietal branch of the left middle cerebral artery (MCA) (n=1). Aneurysms were classified as small (<10 mm) in five of the patients and large(≥10 mm but <25 mm) in seven patients.

A dissecting aneurysm was defined as an aneurysm without a definable neck and usually involved more than 270 degrees of the circumference of the parent vessel. We attempted to study the use of parent artery occlusion to treat saccular and dissecting (ruptured or nonruptured) aneurysms in which surgical clipping was not considered and in which stent-coil and balloon-coil technique were impossible or had failed. All patients underwent parent vessel occlusion by coil. All the procedures were performed under general anesthesia. Anticoagulation was used in all patients. All patients received 5000 U of heparin at the start of the procedure, followed by 1000 U every hour until completion.

A catheter was placed into the common femoral artery in all patients, and selective catheterization of either the vertebral or internal carotid artery was performed. A microcatheter (Echelon 10, MTI-EV3, Irvine, CA, USA) was passed in a coaxial fashion through the guiding catheter followed by selective catheterization of the artery with the aneurysm in each case. The tip of the catheter was placed proximal to the aneurysm. Amytal test was not performed before parent vessel occlusion.

A coil was placed just proximal to the aneurysm in one of the patients, and the aneurysm and parent vessel were occluded with coils in 11



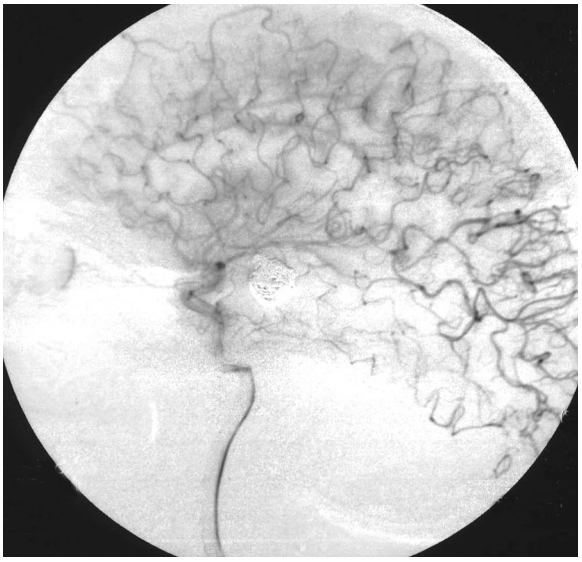


Figure 2 Case 3. A) Three-dimensional reconstruction of the left vertebral injection demonstrated a large dissecting aneurysm of the left P2 segment. After embolization with EDCs, the lateral (B) view obtained with left vertebral injection and the lateral view (C) obtained with a left carotid injection shows occlusion of the P2 segment aneurysm and PCA, with distal perfusion via leptomeningeal anastomoses.

of the patients. Detachable coils were used in 12 patients. Coils were selected on the basis of the size of the artery to be occluded. The smallest artery was occluded with two (2x30 and 2x10, Microvention) detachable coils. Four of the arteries were occluded with 2 mm diameter by 10 mm long complex helical coils. Angiography was performed after coil placement to confirm occlusion of the parent vessel and aneurysm.

Anticoagulation treatment was given to all patients after the procedure to prevent retrograde thrombosis. One patient with a pseudoaneurysm of the right anterior inferior cerebellar artery demonstrated transient diplopia and mild vertigo for two days postoperatively. The postoperative course was uneventful in 11 patients. Patients were discharged, on average, by postoperative day 4 (range, day 3 through day 6). Clinical follow-up ranged from two to eight months (average 5 months).

Seven of the twelve patients had follow-up angiography.

Results

Immediate Results

The procedure was technically successful in all cases. Coil occlusion was performed proximal to the aneurysm in one case, and the aneurysm along with the parent vessel was occluded in eleven cases. Angiography performed immediately after the procedure showed occlusion of the parent vessel with no filling of the aneurysm in all cases. Nine patients had retrograde flow into the peripheral branches of the occluded artery via leptomeningeal collaterals. We encountered no unanticipated complications related to the procedure.

A

B

Figure 3 Case 5. Three-dimensional reconstruction of the left internal injection (A) demonstrated a large dissecting aneurysm of the left M2 segment. The subtracted view of the left internal carotid angiograms, lateral (D) view shows complete obliteration of the aneurysm.

Angiographic Results

Follow-up angiography was performed in seven out of 12 patients from four to seven months after embolization. The angiogram showed no residual filling of the aneurysm in any of the seven patients.

Clinical Results

The period of clinical follow-up was five months on average (range 2 to 8 months). No patient had neurologic deficits from the embolization procedure.

Illustrative Cases

Case 1

A 37-year-old woman presented with sudden onset of headaches, vomiting and weakness of the right leg (Figure 1). Computed tomographic scanning revealed subarachnoid hemorrhage (not shown). Cerebral angiography showed a small dissecting aneurysm involving the P2 segment of the left PCA. A total of two detachable coils (one 4x10, one 2x4; Matrix, Boston Scientific Target) were used to obliterated the aneurysm and parent vessel. The four-month follow-up angiogram studies did not show any recanalization in the aneurysm.

Case 3

A 43-year-old man presented with headaches and heminumbness of the right side (Figure 2). Cerebral angiography showed a giant serpentine aneurysm of the P2 segment of the left PCA. Under general anesthesia, a right femoral puncture was made.

A microcatheter (Echelon 10, M.T.I) was advanced into the aneurysm and platinum coils (Microvention/EDC) were detached. Postembolization assessment showed complete occlusion of the aneurysmal sac, along with the parent P2 segment and the patient demonstrated no visual deficit. Control angiograms showed selective occlusion of the aneurysm and parent vessel. The leptomeningeal network from the anterior circulation supplied the distal PCA territory. The internal and middle temporal trunks served as an aspiration siphon for distal revascularization.

Case 5

A 15-year-old female presented with headaches and weakness of the right arm (Figure 3). Computed tomographic scanning and MR imaging demonstrated a partially thrombolized aneurysm in the left lateral fissure. Angiography showed a large dissecting aneurysm of a branch arising from the left M2 segment. A total of five detachable coils (GDCs) were used to occluded the aneurysm and the parent vessel.

Table 1 **Clinical data of 12 patients with intracranial peripheral aneurysms treated by parent artery occlusion.**

Patient No.	Age Sex	Presentation	Sites, types, sizes of aneurysms	Angiographic outcome	Clinical-angiographic follow-up
1.	37/F	SAH, weakness of the right leg	P2, L, dissection, small	Complete	4-month f/u: GOS=5,no symptoms no recanalization on angiography
2.	49/M	Headaches, hemiparesis(L)	P2, R, saccular, large, thrombosis	Complete	3-month f/u: GOS=4, mild hemiparesis
3.	43/M	Headaches, heminumbness(R)	P2, L, dissection, large	Complete	8-month f/u: GOS=5, no symptoms
4.	48/M	SAH, memory loss, CNIII palsy(R)	P2, R, dissection, large	Complete	5-month f/u: GOS=5, no symptoms, no recanalization on angiography
5.	15/F	Headaches, weakness of the right arm	M3, R,dissection, large	Complete	4-month f/u: GOS=5, no symptoms,
6.	58/F	Intracerebral hemotoma, headaches, hemiparesis(R)	P2, L, saccular, small	Complete	6-month f/u: GOS=4, hemiparesis, hemihypoaesthesia, resolved within 1 month no recanalization on angiography
7.	9/M	Seizure and hypoesthesia of the right arm	M3, L, dissection, large	Complete	6-month f/u: GOS=5, no symptoms, no recanalization on angiography
8.	34/F	Intracerebellar hemorrhage	AICA, R, saccular small	Complete	2-month f/u: GOS=5, no symptoms,
9.	31/M	SAH	P2, L, dissection, large	Complete	7-month f/u: GOS=5, no symptoms no recanalization on angiography
10.	64/F	SAH	PICA, R, saccular small	Complete	6-month f/u: GOS=5, no symptoms no recanalization on angiography
11	4/M	Headaches	P1, R, dissection, large	Complete	3-year f/u: GOS=5, no symptoms
12	53/F	SAH	PICA, L, saccular small	Complete	6-month f/u: GOS=5, no symptoms no recanalization on angiography

SAH: subarachnoid hemorrhage; L: left; R: right; CNIII: the third cranial nerve; small: <10 mm; large: ≥10 mm; f/u: follow-up.

After embolization, the angiogram of the left internal carotid artery demonstrated complete obliteration of the aneurysm.

Discussion

Although several interesting techniques: stent and coil placement and "remodeling" have been used to treat aneurysms of the cerebral arteries, some aneurysms may still be difficult to treat because of their location, size or morphology. For some of these aneurysms, an alternative treatment is parent vessel occlusion. Some literature reports have described the endovascular treatment of intracranial aneurysms by parent artery occlusion [2-10,12-14,16,17-19], but probably because of the relative rarity of distal cerebral aneurysms these reports do not specifically address the treatment of these aneurysms.

To avoid distal cerebral ischemia, preoperative assessment of the symptoms and history of the patients, the anatomy, and the dynamics of

the cerebral circulation is essential. Test injection with Amytal was not perform in our cases because we believe that Amytal testing is overly predictive of deficits owing to its deep penetration into all the peripheral vessels [5,19]. When the vessel is actually occluded, collaterals may partially bypass the occlusion, which accounts for the discrepancy. It is our belief that coils, compared with glue, can be placed precisely, with less chance of distal embolization, which would block possible collateral branches.

Hallacq et Al[9] reported that aneurysms in the P2 segment (the P2 segment extends from the PComA to the posterior edge of the midbrain) are well suited for endovascular obliteration with GDCs because the perforating branches are close to the cerebral peduncle. Some investigators have reported that homonymous hemianopsia developed after proximal P2 occlusion [4,9,18]. Parent artery occlusion resulted in 100% occlusion of all aneurysms without morbidity and no mortality in the absence of revascularization in our patients. This result compares favorably with previously published surgical series [3,4,16]. However, transient seizure and vertigo occurred in patient 5 and patient 8 one day after embolization and was probably related to delayed mass effect. There were no permanent neurologic sequelae from the endovascular treatment of the peripheral aneurysms. The low incidence of visual field defect and other neurologic deficits complicating parent artery occlusion is related to the rich anastomotic collaterals that exist among the PCA, the anterior cerebral artery, MCA, SCA, AICA and PICA [2-10,12-14,16,18,19].

Parent artery occlusion should be a treatment of last resort particularly when temporary vessel occlusion has not been performed to minimize the possibility of ischemia developing after permanent vessel occlusion. Analysis of the angiograms showed that after the point of occlusion distal branches not occluded by the embolic material act as sump aspirators for flow, allowing revascularization of the parent artery via a leptomeningeal supply.

Regrowth of a dissection localized in the middle cerebral artery after being treated with carotid ligation and superficial temporal artery-middle cerebral artery anastomosis has also been reported [1]. An MCA large dissection that underwent complete spontaneous thrombosis after angiography has been described [15], but recanalization is also possible [11]. We believe that surgical revascularization is not always warranted in dissecting aneurysms, although treatment of ruptured P2 segment fusiform aneurysm with PCA-SCA anastomosis combined with parent artery occlusion has been reported [14].

We proposed the strategy of parent artery occlusion in distal dissecting or saccular aneurysms if selective coiling cannot be achieved during endovascular treatment. The rational behind this strategy is based on the following reasons: the high risk of alternative reconstructive surgery in distal artery; the increased morbidity and even mortality caused by addition of a balloon or stent to the endovascular technique; the relative lack of data on the use of balloon or stent in distal vessels; and lastly and most critically, the data in the surgical literature suggesting that there is no difference in outcome whether or not the parent artery is preserved during the treatment of aneurysms in this arterial territory [4,17].

Because well-developed collateral vascular pathways supply the distal PCA and MCA territory after its occlusion, the management can be to proceed directly to combined occlusion of the parent vessel and aneurysm [3,4,9,18]. In one of our patients with peripheral AICA aneurysm treated by parent vessel occlusion, an excellent result was obtained without significant complications. In contrast to most cases previously reported, in which a surgical procedure was used, the patient did not demonstrate any neurological sequelae. Endovascular obliteration is also a reasonable option for aneurysms at the distal to the meatal loop of the right AICA, although the possibility of retrograde thrombosis of the AICA is a concern.

Conclusions

In our experience, distal parent artery occlusion of the posterior cerebral artery, the middle cerebral artery, the anterior inferior cerebellar artery and the posterior inferior cerebellar artery is typically well tolerated for large saccular and dissecting aneurysms. With good selection and appropriate technique, some of these aneurysms may be treated successfully by parent vessel occlusion.

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